Public Works (1903) Department.

G.O., No. 420
421

DATED 9 April 1903.

[illegible pencil annotations: "3 copies of G.O. ... copies of Endt with ... ticked at the back ... 35 copies of Endt ... "]

11/4/03

[Despatch Abstract.]

Falling Shutters of the Periyar Escape Channel

Directing the S.E. VI circle to submit plans and estimates for the —— as recommended by the Inspector-General of Irrigation, and ordering that a copy of the Pros: be forwarded to the G. of I for information.

Falling shutters of the Periyar Escape Channel

Forwarding a copy of the Pros: directing the S.E. VI circle to submit plans and estimates for the —— as recommended by the Inspector General of Irrigation.

P. W. D. 500—12-8-01.

தமிழ்நாடு ஆவணக்காப்பகம்
பாதுகாப்பு பிரிவு

செப்பனிட்டவரின் பெயர் : ம. மதிவாணன்

செப்பனிடுவதற்கு 9/13

எடுத்துக்கொண்ட நாள் : 10/13

செப்பனிட்டு முடித்த நாள் :

- - சரிபார்க்கப்பட்டது - -

28/10/13 29/11/13 28/4/13

முநிபாள(1) முநிபாள(2) ஆராய்ச்சி உதவியாளர்

IRRIGATION.
ACCOUNT.

2/420

# Government {1903} of Madras.

## PUBLIC WORKS.

*Recd.* } 1903. *Enclosures*

*Regd.* *Spare copies*

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## G.O., Nos. 420, 421 I., 9th April 1903.

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## APRIL.

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**Falling Shutters of the Periyar Escape Channel**

Forwarding a copy of the proceedings directing the Superintending Engineer, VI Circle, to submit plans and estimates for the — as recommended by the Inspector-General of Irrigation.

## GOVERNMENT OF MADRAS.

## PUBLIC WORKS. DEPARTMENT.

### Irrigation.
### Account.

Read—the following papers :—

From W. L. STRANGE, Esq., Under Secretary to the Government of India, Public Works Department (Civil Works—Irrigation), to the Joint Secretary to the Government of Madras, Public Works Department, Irrigation Branch, dated Calcutta, 16th March 1903, No. 396 C.W.I.

Referring to the correspondence ending with your endorsement No. 585 I., dated 29th July 1898, relating to proposals in connection with improvements to the waste weir of the Periyár dam to enable it safely to discharge the floods that may be expected, I am directed to forward a note on the subject, by Sir T. Higham, K.C.I.E., late Inspector-General of Irrigation, and to state that the Government of India desire that effect should be given to the recommendations therein made and that estimates embodying them should be submitted as soon as possible, so that the work may be put in hand as early as possible.

2. They consider that, in addition to these proposals, the bed of the waste weir channel should be excavated with a longitudinal slope of 1 in 100 downstream from the line of the proposed shutters so as to pass off floods with an increased velocity and lessened tail depth in the channel. This increased velocity will require a greater afflux to produce it, but the effect of giving the tail channel a longitudinal slope will be considerably to increase the discharging power of the weir with any given surface level in the tank. This is illustrated by the following table :—

| Weir crest. | Weir tail channel longitudinal slope. | Flood depth. | | | Discharge. | Mean velocity. |
|---|---|---|---|---|---|---|
| | | Tail. | Afflux. | Total. | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | | FEET. | FEET. | FEET. | CUSECS. | FEET PER SECOND. |
| 1. Existing .. .. .. | Level .. | 10·00 | 1·90 | 11·90 | 40,230 | 9·27 |
| 2. ,, .. .. .. | 1 in 100 .. | 5·90 | 5·10 | 11·00 | 50,881 | 19·85 |
| 3. Lowered 4 .. .. | Level .. | 14·00 | 2·90 | 16·90 | 70,330 | 11·67 |
| 4. ,, .. .. .. | 1 in 100 .. | 7·90 | 7·10 | 15·00 | 82,526 | 24·07 |

3. The above table also shows that, owing both to the increased discharge and to the diminished tail depth, the velocity of the water due to the slope given to the tail channel will be very considerably increased. It will, therefore, have to be carefully considered by the Government of Madras whether the rock, forming the bed of the tail channel, is sufficiently compact and hard to withstand its eroding effect. It is suggested that that portion of the tail channel which is of short length, *i.e.*, where the natural hill slope approaches close to the line of the proposed crest shutters, should be excavated with a level bed (*vide* marginal sketch). This will

not only lessen the velocity there, but will also tend to divert the flow over it to the

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portions of the tail channel the length of which is greater and to which the longitudinal slope of 1 in 100 would be given. Any erosion which may there occur will less prejudicially affect the weir as a whole.

4. The effect of thus making part of the tail channel with a level bed will, of course, be somewhat to reduce the total discharging power of the weir. Calculations of the actual discharge of the weir as altered should be submitted with the estimate embodying the proposals now called for. These calculations need only be approximate ones, the discharge of each section of the tail channel being taken in the proportion its width bears to that of the whole. Thus, assuming the portion with the level bed extends for $\frac{1}{3}$rd the width of the whole tail channel from the above table, the discharge of the lowered weir would be : $\frac{2}{3}$ (82,526) + $\frac{1}{3}$ (70,330) = 55,017 + 23,443=78,460 cusecs. Detailed calculations of the discharge of the weir, with a tail channel slope of 1 in 100, are attached.

5. The plans and estimates received with your endorsement referred to are returned herewith.

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## Enclosures.

### Note by Sir THOMAS HIGHAM, K.C.I.E., Inspector-General of Irrigation, on the escapage capacity of the Periyár Project, dated 19th October 1902.

*Proposals submitted by the Government of Madras.*

The Government of Madras have submitted for consideration two estimates for increasing the escape capacity at Periyár. One of them amounting to Rs. 56,500 provides for the lowering of the bed of the escape channel by 3 feet and erecting a permanent weir, or bar, for maintaining full supply at present level (R.L. 144·00). The second, amounting to Rs. 7,100, provides for the removal of the parapet on the main dam, and the substitution of an iron railing, so that surplus may be passed over the dam after the level in the lake has risen to R.L. 155·00. The former has been recommended by the Chief Engineer as a preferable alternative to the latter, but the two proposals are not necessarily alternative, for the execution of both may be contemplated, the one being supplementary to the other. I agree, at any rate, that the removal of the parapet wall will not give anything like the relief required, and that it cannot be accepted as an alternative to the lowering of the bed of the escape.

*Chief Engineer's calculations of the discharging capacity of the present escape.*

2. I have obtained from Madras copies of the detailed calculations from which the figures in the margin of the Chief Engineer's note, dated 28th June 1898, were derived, and accept as sufficiently correct for present purposes the discharges due to different depths at the tail of the escape, and the resulting depths at head of the escape as given in that note. The Chief Engineer appears, however, to have made no allowance for the loss of head due to the afflux required at the head of the escape channel in order that the still water of the lake may enter the channel with the proposed velocity. The height of this afflux is a very important factor in every problem relating to the capacity of the escape.

*Maximum capacity of the present escape allowing for afflux at the head.*

3. Let us just consider the capacity of the present escape as it stands, assuming a depth of 10′ at the tail end of the escape channel. According to the Chief Engineer's calculations, this will represent a discharge of 40,230 cusecs, and there will be a rise in the water surface of 0·7 feet in the length of the escape, so that the depth at the upper end of the channel will be 10·7 feet, the level of the surface being R.L. 154·7, if we take the bed of the escape at a uniform level of R.L. 144·00. Then the afflux may be determined by means of the following formula :—

$$D = c_1 l \sqrt{2gh_1} (h_2 + \tfrac{2}{3} h_1) \text{ or } \frac{D}{c_1 l \sqrt{2g}} = \sqrt{h_1} (h_2 + \tfrac{2}{3} h_1) \quad \ldots\ldots\ldots (a)$$

where $D$ = discharge = 40,230 cusecs

$c_1$ = co-efficient, say 0·75 *

$l$ = width of channel in feet = 434 feet.

$h_1$ = afflux at head of channel in feet.

$h_2$ = depth of water in channel in feet = 10·0 feet.

$g$ = gravity and $\sqrt{g}$ = 8·02

* This is perhaps too high a value, but if so, the required afflux will be even greater than calculated below. T.H.

Writing equation (*a*) thus :— $\frac{D}{c_1 l \sqrt{2g}} = \sqrt{h_1}\,(h_2 + \frac{2}{3} h_1)$,

and substituting the above values and assuming $h_1 = 1{\cdot}88$,

$$\frac{D}{c_1 l \sqrt{2g}} = \frac{40{,}230}{2{,}610{\cdot}5} = 15{\cdot}41\,;\ \sqrt{h_1}\,(h_2 + \tfrac{2}{3} h_1) = 15{\cdot}41.$$

Whence $h_1 = 1{\cdot}9$ feet nearly, and the level of water in the lake to give a discharge of 40,230 cusecs, corresponding to a depth $h_2 = 10$ feet at tail of escape, will be R.L. 154·7 + 1·9 = R.L. 156·6 nearly, or only 1·4 feet below the top of the parapet of the dam. This is about the level contemplated by the Chief Engineer, and cannot be much exceeded with safety *, so that we may take the maximum discharging capacity of the escape at little more than 40,230 cusecs.

* I should regard 157·00 as the extreme limit.

T.H.

*Effect of such a flood as that of November 1866.*

4. According to Table IV in the papers on the Periyár Project (No. CCXV records of Government of India, Public Works Department) the estimated run-off, or quantity that would enter the lake in 24 hours after the rainfall of 17th to 19th November 1869, was 5,705·5 millions of cubic feet, which is equivalent to a discharge of 66,036 cusecs, or a run-off of a little more than $\frac{1}{3}$ of an inch per hour for 24 hours over the whole catchment area of 305 square miles, which would be equivalent to a discharge of 65,608 cusecs. For present purposes the required maximum discharge capacity of the escape may be calculated with sufficient accuracy by the following formula :—

I = rate of influx into lake in cubic feet per second ;

t = time in seconds = 24 × 60 × 60 = 86,400 (or 0·0864 million) seconds in one day ;

Q = It = quantity of water entering lake in time t, or in 24 hours = 5,805·5 million cubic feet ;

V = Volume between the R. L. 144·0 contour, or full supply level, and the level to which water will rise at end of time t or R.L. 156·4.

| | | Million cubic feet. |
|---|---|---|
| Capacity at ... ... ... ... ... | R.L. 156·4 | = 17,076 |
| " ... ... ... ... ... | R.L. 144·0 | = 13,299 |
| Therefore V = ... ... ... ... ... ... | | 3,777 |

O = discharge of outlet or tunnel per second which may be assumed at 1,100 cusecs ;

D = Required maximum discharge in escape ;

then $\frac{D}{2}$ = average discharge = $\frac{(Q - V - Ot)}{t}$ ........................................(*b*)

and $D = \frac{2\ \{5{,}805{\cdot}5 - 3{,}777 - (1{,}100 \times 0{\cdot}0864)\}}{0{\cdot}0864}$

= 44,756 cusecs.

It has, however, been shown that the maximum discharging capacity of the escape with the surface of the lake at the 156·4 contour is only 40,230 cusecs. It is therefore evident that a flood such as that of November 1869 coming on a full lake could not be passed until the surface level in the lake had risen above the 156·4 contour, and probably fully up to the R.L. 157·00 contour.

*Flood that should be provided for.*

5. It may well be doubted, however, whether the flood of November 1869, as estimated, is the maximum that should be provided for. As already shown, the corresponding run-off was only slightly in excess of $\frac{1}{3}$ of an inch per hour (for 24 hours). It is understood that the river was gauged in 1869 at a point 10 miles above the present dam, so that it did not include the whole of the catchment area. The escapages at Lake Whiting and Lake Fife were calculated for runs-off $\frac{5}{8}''$ and $\frac{1}{2}''$, respectively, over the whole catchment for 24 hours, and considering the scantiness of the records of rainfall over the Periyár catchment area, and the want of details of the flood observations of November 1869, it seems desirable to contemplate a run-off of half an inch an hour for 24 hours.

*Discharge due to a depth of 14 feet at the tail of the escape.*

6. The Chief Engineer calculates that, with a depth of 14 feet at the tail of the escape, there will be a discharge of 70,330 cusecs. It will be convenient to assume that the escape bed is lowered 4 feet at head, or to R.L. 140·00, and given a bed fall of 0·7 feet so that the bed level at tail of the channel, or at the overfall, will be R.L. 139·3. The afflux at the head of the channel will then be given by formula (*a*) substituting the new values for D and $h_2$ *viz* :—

$$\frac{D}{c_1 l \sqrt{2g}} = \frac{70{,}330}{2{,}610{\cdot}5} = 26{\cdot}94 = \sqrt{h_1}\,(14{\cdot}0 + \tfrac{2}{3} h_1).$$

Whence $h_1 = 2{\cdot}9$ feet nearly, and the level of the surface of the lake which will give the required discharge will be R.L. 140·00 + 14·0 + 2·9 = R.L. 156·9.

*The run-off which can be provided for by a maximum discharge of 70,330 cusecs.*

7. The run-off which can be provided for by such a discharge, allowing for the flood absorptive capacity of the reservoir itself, has next to be considered. Formula (*b*) requires some modification, because if we lower the bed of the escape channel 4 feet (holding up the water by means of falling shutters), the initial discharge will not be *nil*, but will be that due to a depth of 4 feet. If $D_1$ and $D_2$ represent the initial and terminal discharges at the beginning and the end of the assumed period of 24 hours then formula (*b*) becomes—

$$\frac{(D_1 + D_2)}{2} t = Q - V - O\,t$$

$$\text{or } Q = \frac{(D_1 + D_2 + 2\,O}{2}\,t + V \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (c).$$

Mr. Hughes gives the discharge due to a depth of 4 feet at the lower end of the escape as 9,630 cusecs, but some allowance must be made for the loss of head due to the afflux at the head of the channel, and we may take—

$D_1 = 9.270$
$D_2 = 70{,}330$
$V = 3{,}943$ M. c. f. *

| | | M. c.ft. |
|---|---|---|
| * Capacity at | R.L. 156·9 | =17,242 |
| ,, ,, | R.L. 144·0 | =13,299 |
| Difference .. | .. | 3,943 |

$$\text{Then } Q = \frac{79{,}600 + 2{,}200}{2} \times 86{,}400 + 3{,}943{,}000{,}000 = 7{,}476{,}760{,}000 \text{ c ft. in 24 hours, and}$$

$I = 86{,}537$ cubic feet per second.

This is equivalent to a run-off of 0·44 inches per hour over the whole catchment area, instead of the whole half inch proposed. If this run-off is exceeded, the surface level of the lake is likely to rise above the R.L. 156 90 contour, which shows that, even if the bed of the escape channel be lowered to the full extent now proposed, it will not give quite the full capacity which may be considered desirable, but some further relief may be given by removing the parapet of the main dam.

*Disadvantages of a permanent weir with crest at R.L. 144·00.*

8. These results are attained on the assumption that the water is held up to full supply level (R.L. 144·00) by falling shutters which are dropped in succession as the water rises above this level. The Chief Engineer however objects to the shutters and purposes to construct a permanent weir, or bar, with crest at R.L. 144·00. The effect of such a bar would be to cause a further loss of head owing to the afflux above the weir for which Mr. Hughes allows a height of 1 foot only. This second afflux will affect and somewhat reduce the afflux at the head of the escape channel. It is certain however that the total loss of head due to the combined affluxes must be much greater than that (2·9 feet) which has been shown to be due to the afflux at head of the channel for a full discharge of 70,330 cusecs. Even if the excess is only half a foot (and it would doubtless be much more) this would involve a serious reduction in the value of $D_2$ in the preceding formula, or of the maximum or final discharging power of the escape, when the level of 156·9 had been attained in the lake. But there is a more serious objection. With falling shutters the initial discharge ($D_1$) at the R.L. 144·00 contour may be as high as 9,270 cusecs whereas with a permanent weir it will be *nil*, so that not only will the value of $D_2$ in equation (c) be greatly reduced, but that of $D_1$ will disappear altogether. It is difficult to determine quantitatively the loss of head which would be caused by the construction of a weir, at some point between the head and tail of the channel, for the short length of the escape channel, the irregularity of its bed and of the overfall in plan and many other considerations render the ordinary formulæ inapplicable, but the minimum loss will be on the assumption that the weir is placed at the head of the channel so that there will be but a single afflux. Take the lake level at R.L. 157·00, then the discharge for a depth of 140 feet in the escape channel will be given by the formula—

$$D = c_1\,l\,\sqrt{2g}.\ \ \sqrt{h_1}\left(h = \frac{h_1}{3}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (d)$$

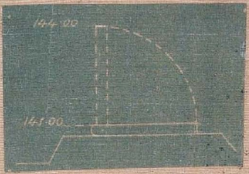
$$= 2{,}610{\cdot}5 \times \sqrt{3} \times 12{\cdot}0 = 54{,}246 \text{ cusecs.}$$

This corresponds very closely with the discharge calculated by Mr. Hughes for a depth of 12 feet at the tail of the escape channel. If we substitute for $D_1$ and $D_2$ in equation (c) the values *nil* and 54,246 now found, the value of I, or rate of influx per second, which can be accommodated, will be reduced from 86,537 to 73,859 cusecs, for a maximum flood level of

R.L. 157·00. It has, however, been shown that under present conditions a rate of influx of 67,193 cusecs can be accommodated for a maximum flood level of R.L. 156·4, so that there will be little advantage in incurring the expense of lowering the bed of the escape as proposed if a permanent weir with crest at R.L. 144·00 is also constructed.

Chief Engineer's objections to falling shutters.

9. The Chief Engineer objects to falling shutters on the ground that they could not be worked without great loss of water since they could not be raised until water had fallen 1½ or 2 feet below full lake level. There should, however, be no real difficulty in lifting the shutters against a 4-feet head of water. At Rupar shutters 6 feet in length are constantly lifted by the aid of a crane against a head of 6 feet, and recent experience at Bezwada will probably show that the apprehensions of the Chief Engineer are unfounded. There would be no objection to a low bar such that the shutters when lying down on it would not be higher than R.L. 141·00, and the head against which they would have to be lifted would then be reduced to 3 feet. These could be raised by hand faster than the lake level will fall if a strong gang of coolies can be employed, or a travelling crane might be used as at Rupar. The simplest plan would be to construct a gantry of iron standards upstream of the line of shutters, from which the shutters could be raised into position by means of a tackle or winch, but this would be rather costly. Even allowing for establishment difficulties at Periyár, the Madras officers will no doubt be able to devise a number of ways of working falling shutters which will not involve the loss of any water, and in view of the great loss of escape power which will be caused by the erection of a non-removeable dam the use of falling shutters appears to me to be obligatory.




Removal of the parapet of the main dam.

10. The proposal to cut down the parapet of the main dam to R.L. 155·00 may next be considered. It will afford very little additional escape power as this means of escape will not come into play at all until the lake has risen to R.L. 155·00. The discharge over a 600 feet* length would not be more than 6,000 cusecs with lake level at 157·00, so that the average discharge while the lake level was rising from R.L. 155·00 to 157·00 would be only 3,000 cusecs. No objection need be taken to the proposal however if it is desired to carry it out as a supplementary measure in addition to the lowering of the bed of the escape. The small quantity of water which will pass over the dam for a short time on the rare occasions of such exceptional floods as are contemplated will not injure the dam, but will provide a desirable increase in the margin of safety at a comparatively small cost.

* It would be better to pass the water over the central 500 feet only.

T. H.

Other methods of increasing the escape power.

11. There may be other ways of providing the required increase in the escape power, as for instance, by widening the escape channel, or by inserting low level undersluices in the subsidiary dam. The latter plan would be very effective as it could enable water to be passed to escape on the sudden advent of a flood even when the lake was below R.L. 144·00, but, although, as far as can be judged, the cost of both these alternatives is likely to be excessive, they may deserve consideration.

Possibility of a future increase in the storage capacity of the lake.

12. When I was at Madura with the Irrigation Commission I understood that it was contemplated that it would sooner or later be necessary to increase the storage of the lake so as to extend the area under irrigation. The escapage now proposed will however be insufficient if the full supply level is raised materially above R.L. 144·00, or if the flood absorptive capacity of the lake, as measured by the contents between the full supply and maximum flood contours, is much reduced. It must be clearly recognized that any increase in the present storage will necessitate greater escape facilities, but this strengthens rather than weakens the case for the present proposals. Any measures that may now be taken for improving the existing means of escape by lowering or widening or regrading the bed of the channel will be all to the good. If the storage is increased, it may be necessary eventually to cut down the bed to a lower level than R.L. 140·00, to increase the width, and to substitute, for the inexpensive falling shutters now proposed a costly system of self-adjusting gates, like those on Lake Whiting or Lake Fife. The cost of such works will of course be fairly chargeable to the extension project, but, whatever can be now done to improve the escape or surplussing capacity of this important work, will reduce *pro tanto* the cost of future measures in the same direction which will be a *sine quâ non* if it is proposed to increase the storage.

5 5/420

No. 420 I., 9th April 1903.

13. I recommend therefore that the Government of Madras be advised to increase the surplussing power of the escape to the extent now proposed, and suggest that this should be done by cutting down the bed of the escape channel to R.L. 140·00 at the upper, and to R.L. 139·30 at the lower, end, and that the water should be held up to present full supply level (R.L. 144·00) by means of falling shutters to be hinged at the bottom and released as necessary by hand, suitable arrangements being made for lifting them against a head of 3 or 4 feet of water. If considered desirable, the parapets on the main dam may also be removed and replaced by an iron railing. If the local officers consider that the required increase in the escape power can be obtained by other more suitable or economical measures, they may be estimated for as alternative proposals, but the possibility that a further increase in the capacity of the escape may be necessary, if it is decided hereafter to increase the full supply level, should be borne in mind in submitting final proposals, although it will not be necessary to anticipate or provide for an increase of storage at present.

Recommendations.

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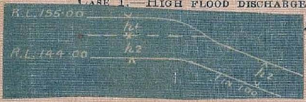
Case 1.—High flood discharge of existing right bank channel with slope 1 in 100.




*A.—Tail channel discharge.*

Assume $h_2 = 5·90$ feet.

$D = a\sqrt{r}.c\sqrt{s}$

$= 2,561 \times 2·4 \times 82·7 \times 0·1$

$= 50,831$ cusecs.

Mean velocity $= 19·85$ feet per sec.

$a = 434 \times 5·9 = 2,561$

$r = \frac{a}{wp} = \frac{2,561}{445·3} = 5·74$

$\sqrt{r}$ .............. $= 2·40$

$c$ .............. $= 82·7$

$s = 0·01$; $\sqrt{s}$ .. $= 0·1$

*B.—Afflux height.*

Assume $h_1 = 5·10$ feet.

$$\frac{D}{8·02\, c_1 b} = \frac{50,831}{8·02 \times 0·7 \times 434} = \frac{50,831}{2,436} = 20·87.$$

$$\sqrt{h_1}\left(h_2 + \frac{2}{3}h_1\right) = \sqrt{5·1}\left(5·9 + 3·4\right) = 2·26 \times 9·3 = 21·02.$$

The values of the two sides of the equation are thus practically the same, and the assumptions are thus practically correct, therefore :—

Afflux = 5′·10; tail depth = 5′·90; total flood depth = 11′·00.
Discharge = 50,831 cusecs.

This discharge is equal to a run-off from the catchment of $\frac{50,831}{196,826} = 0·26$ inch per hour.

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Case 2.—High flood discharge of lowered right bank channel with slope 1 in 100.

*A.—Tail channel discharge.*

Assume $h_2 = 7·90$ feet.
$D = a\sqrt{r}.c\sqrt{s}$
$= 3,429 \times 2·76 \times 87·2 \times 0·1$

$= 82,526$ cusecs.

Mean velocity $= 24·08$ feet per sec.

$a = 434 \times 7·9 = 3,429$

$r = \frac{a}{wp} = \frac{3,429}{449·8} = 7·62$

$\sqrt{r}$ .............. $= 2·76$

$c$ .............. $= 87·2$

$s = 0·01$; $\sqrt{s}$ . . $= 0·1$

*B.—Afflux height.*

Assume $h_1 = 7·10$ feet.

$$\frac{D}{8·02\, c_1 b} = \frac{82,526}{8·02 \times 0·7 \times 434} = \frac{82,526}{2,436} = 33·87$$

$$\sqrt{h_1}\left(h_2 + \frac{2}{3}h_1\right) = \sqrt{7·1}\left(7·9 + 4·73\right) = 2·66 \times 12·63 = 33·60.$$

The values of the two sides of the equation are thus practically the same, and the assumptions are thus practically correct.

∴ Afflux = 7·10′; tail depth = 7·90′; total flood depth = 15·00′.
Discharge = 82,526 cusecs.

This discharge is equal to a run-off from the catchment of $\frac{82,526}{196,826}$ = 0·42 inch per hour.

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No. 76 I.

*Note by the Chief Engineer for Irrigation.*

With endorsement No. 585 I., dated 29th July 1898, estimates were forwarded, for the consideration and orders of the Government of India, for lowering the bed of the Periyár escape channel and constructing a weir, 150 feet, on the lake-side of the present weir and lowering the parapet of the main dam. The Government of India now forward a note by Sir T. Higham, late Inspector-General of Irrigation, on the subject and direct that estimates embodying the recommendations therein made be prepared and submitted as soon as possible.

The Superintending Engineer may be directed to submit the plans and estimates for the falling shutters as ordered by the Inspector-General of Irrigation. The undersigned is, however, of opinion that we should build a regulator at once with lift-shutters. It is not known in this office what progress has been made in the investigation of the proposed increase of capacity of the Periyár lake. It may be assumed for present purposes that the project will not be sanctioned for two or three years to come. In this case it would be advisable to build a regulator at once with spans of 40 feet and shutters 6 feet deep, similar to those recently erected at the Upper Coleroon anicut. A discharge of 100,000 cusecs may be assumed as a maximum. One of these shutters cost at the Upper Coleroon complete and fitted up, Rs. 5,000; the cost at Periyár may be taken at Rs. 6,000. If eventually it is found necessary to raise the F.S.L. of the lake, these shutters may become the tops of the new and deeper shutters that may then be required. The platform would in this case require raising and the chains lengthening. The gearing, etc., of winches should be made now sufficiently strong to work the heavier shutter.

(Signed) A. W. SMART, Col., R.E.,
Chief Engineer for Irrigation.

2nd April 1903.

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ORDER—No. 420 I., dated 9th April 1903.

The Superintending Engineer, VI Circle, will submit the plans and estimates for the falling shutters as recommended by the Inspector-General of Irrigation.

2. Ordered that a copy of these proceedings be forwarded to the Government of India for information with reference to their letter, No. 396 C.W.I., dated 16th March 1903.

[Here enter No. 421 I., dated 9th April 1903.]

(True Extract.)

(Signed) A. W. SMART, Col., R.E.,
Joint Secretary to Government,
Irrigation Branch.

To the Chief Engineer for Irrigation.
" Superintending Engineer, VI Circle,
with plans and estimates and a blue print of Upper Coleroon shutters.

6/420

No. 420 I., 9TH APRIL 1903.

ENDORSEMENT—No. 421 I., dated 9th April 1903.

Forwarded.

(By order.)

(Signed) A. W. SMART, Col., R.E.,
Joint Secretary to Government,
Irrigation Branch.

2

E.I. / 5 4,000—19-3-02.

# Public Works (1903) Department

## (IRRIGATION BRANCH.)

For Office ... papers 2/3/03

**CURRENT No.** 3222

*From*

*[Name]* The Government of India. P.W.D.

*[Designation]*

*[Station]*

*No.* 396. C.W.I.

*Dated* 16. 3. 1903.

*Enclosures* { *Plans* 5 / *Others* 10 } *Total* 15

*Spare copies* 9.

*Received* 190 .

*Registered* 21 - 3 - 1903

SUBJECT.

Waste Weir of the Periyar dam.

Forwarding a note by Sir T. Higham in connection with improvements to —

BACK PAPERS.

FURTHER PAPERS.

8/420

*All communications should be addressed to the Secretary.*

No. 396 C.W.I.

GOVERNMENT OF INDIA.

PUBLIC WORKS DEPARTMENT.

(CIVIL WORKS—

IRRIGATION.)

18

To

The Joint Secretary to the Government of Madras,
Public Works Department, Irrigation Branch.

Calcutta, the 16th March 1903.

Sir,

Referring to the correspondence ending with your endorsement No. 585 I., dated 29th July 1898 relating to proposals in connection with improvements to the Waste Weir of the Periyar Dam to enable it safely to discharge the floods that may be expected, I am directed to forward a note on the subject by Sir T. Higham. K.C.I.E., late Inspector General of Irrigation, and to state that the Government of India desire that effect should be given to the recommendations therein made and that estimates embodying them should be submitted as soon as possible so that the work may be put in hand as early as possible.

2. They consider that, in addition to these proposals, the bed of the Waste Weir channel should be excavated with a longitudinal slope of 1 in 100 downstream from the line of the proposed shutters so as to pass off floods with an increased velocity and lessened tail depth in the channel. This increased velocity will require a greater afflux to produce it, but the effect of giving the tail channel a longitudinal slope will be considerably to increase the discharging power of the weir with any given surface level in the tank. This is illustrated by the following

table

table :-

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Weir Crest | Weir tail channel longitudinal slope. | Flood depth | | | Discharge | Mean velocit |
| | | Tail | Afflux | Total | | |
| | | ft. | ft. | ft. | cusecs | ft.per |
| 1.Existing | Level | 10.00 | 1.90 | 11.90 | 40,230 | 9.27 |
| 2. " | 1 in 100 | 5.90 | 5.10 | 11.00 | 50,831 | 19.85 |
| 3.Lowered 4 | Level | 14.00 | 2.90 | 16.90 | 70,330 | 11.57 |
| 4. " | 1 in 100 | 7.90 | 7.10 | 15.00 | 82,525 | 24.07 |

3. The above table also shows that, owing both to the increased discharge and to the diminished tail depth, the velocity of the water due to the slope given to the tail channel, will be very considerably increased. It will therefore have to be carefully considered by the Government of Madras whether the rock forming the bed of the tail channel is sufficiently compact and hard to withstand its eroding effect. It is suggested that that portion of the tail channel which is of short length, i.e. where the natural hill slope approaches close to the line of the proposed crest shutters, should be excavated with a level bed (vide marginal sketch). This will not only lessen the velocity there but will also tend to divert the flow over it to the portions of the tail channel the length of which is greater and to which the longitudinal slope of 1 in 100 would be given. Any erosion which may there occur will less prejudicially affect the weir as a whole.

4. The effect of thus making part of the tail channel with a level bed will, of course, be somewhat to reduce the total discharging power of the weir. Calculations of the actual discharge of the weir as altered should be submitted with the estimate embodying the proposals now called for. These calculations need only be approximate ones, the discharge of each section of the tail channel being

taken

2 P 9/420

~~xxxxx~~ taken in the proportion its width bears to that of the whole. Thus, assuming the portion with the level bed extends for 1/3rd the width of the whole tail channel from the above table the discharge of the lowered weir would be:—

$\frac{2}{3}$ (82,526) + $\frac{1}{3}$ (70,330) = 55,017 + 23,443 = 78,460 cusecs

Detailed calculations of the discharge of the weir, with a tail channel slope of 1 in 100 are attached.

5. The plans and estimates received with your endorsement referred to are returned herewith.

I have the honour to be,

Sir,

Your most obedient servant,

W L Strange

Under Secy. to the Govt. of India.

Documents accompanying.

Note, plans, estimates and calculations referred to.

S.R.

10/420 3 Sb

Enclosure

***Note by Sir* THOMAS HIGHAM, *K.C.I.E., Inspector General of Irrigation, on the escapage capacity of the Periyar Project.***

---

*Proposals submitted by the Government of Madras.*

1. The Government of Madras have submitted for consideration two estimates for increasing the escape capacity at Periyar. One of them amounting to Rs. 56,500 provides for the lowering of the bed of the escape channel by 3 feet, and erecting a permanent weir, or bar, for maintaining full supply at present level (R. L. 144·00). The second amounting to Rs. 7,100 provides for the removal of the parapet on the main dam, and the substitution of an iron railing, so that surplus may be passed over the dam after the level in the lake has risen to R. L. 155·00. The former has been recommended by the Chief Engineer as a preferable alternative to the latter, but the two proposals are not necessarily alternative, for the execution of both may be contemplated, the one being supplementary to the other. I agree, at any rate, that the removal of the parapet wall will not give anything like the relief required, and that it cannot be accepted as an alternative to the lowering of the bed of the escape.

*Chief Engineer's calculations of the discharging capacity of the present escape.*

2. I have obtained from Madras copies of the detailed calculations from which the figures in the margin of the Chief Engineer's note dated 28th June 1898, were derived, and accept as sufficiently correct for present purposes the discharges due to different depths at the tail of the escape, and the resulting depths at head of the escape as given in that note. The Chief Engineer appears, however, to have made no allowance for the loss of head due to the afflux required at the head of the escape channel in order that the still water of the lake may enter the channel with the proposed velocity. The height of this afflux is a very important factor in every problem relating to the capacity of the escape.

*Maximum capacity of the present escape allowing for afflux at the head.*

3. Let us just consider the capacity of the present escape as it stands, assuming a depth of 10 feet at the tail end of the escape channel. According to the Chief Engineer's calculations this will represent a discharge of 40,230 cusecs, and there will be a rise in the water surface of 0·7 feet in the length of the escape so that the depth at the upper end of the channel will be 10·7 feet, the level of the surface being R. L. 154·7, if we take the bed of the escape at a uniform level of R. L. 144·00. Then the afflux may be determined by means of the following formula :—

$$D = c_1 l \sqrt{2gh_1}\,(h_2 + \tfrac{2}{3} h_1) \quad \text{or} \quad \frac{D}{c_1 l \sqrt{2g}} = \sqrt{h_1}\,(h_2 + \tfrac{2}{3} h_1) \quad \ldots\ldots\ldots\ldots (a)$$

where $D$ = discharge = 40,230 cusecs

$c_1$ = co-efficient, say 0·75*

$l$ = width of channel in feet = 434 feet.

$h_1$ = afflux at head of channel in feet.

$h_2$ = depth of water in channel in feet = 10·0 feet.

$g$ = gravity and $\sqrt{g}$ = 8·02.

* This is perhaps too high a value, but if so, the required afflux will be even greater than calculated below.

T. H.

Writing equation (a) thus :— $\frac{D}{c_1 l \sqrt{2g}} = \sqrt{h_1}\,(h_2 + \tfrac{2}{3} h_1)$,

and substituting the above values and assuming $h_1$ = 1·88,

$$\frac{D}{c_1 l \sqrt{2g}} = \frac{40,230}{2,610·5} = 15·41\ ;\ \sqrt{h_1}\,(h_2 + \tfrac{2}{3} h_1) = 15·41.$$

Whence $h_1$ = 1·9 feet nearly, and the level of water in the lake to give a discharge of 40,230 cusecs, corresponding to a depth $h_2$ = 10 feet at tail of escape, will be R. L. 154·7 + 1·9 = R. L. 156·6 nearly, or only 1·4 feet below the top of the parapet of the dam. This is about the level contemplated by the Chief Engineer, and cannot be much exceeded with safety,† so that we may take the maximum discharging capacity of the escape at little more than 40,230 cusecs.

† I should regard 157·00 as the extreme limit.

T. H.

*Effect of such a flood as that of November 1866.*

4. According to Table IV in the papers on the Periyar Project (No. CCXV records of Government of India, Public Works Department) the estimated run-off, or quantity that would enter the lake in 24 hours after the rainfall of 17th to 19th November 1869, was 5,705·5 millions of cubic feet, which is equivalent to a discharge of 66,036 cusecs, or a run-off of a little more than $\frac{1}{3}$ of an inch per hour for 24 hours over the whole catchment area of 305 square miles, which would be equivalent to a discharge of 65,608 cusecs. For present purposes the required

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maximum discharge capacity of the escape may be calculated with sufficient accuracy by the following formula :—

$I$ = rate of influx into lake in cubic feet per second ;

$t$ = time in seconds = $24 \times 60 \times 60 = 86,400$ (or 0·0864 million) seconds in one day ;

$Q = It$ = quantity of water entering lake in time t, or in 24 hours = 5,805·5 million cubic feet ;

$V$ = Volume between the R. L. 144·0 contour, or full supply level, and the level to which water will rise at end of time t or R. L. 156·4.

| | | Million cubic feet. |
|---|---|---|
| Capacity at . . . . . . . | R. L. 156·4 | = 17,076 |
| ,, . . . . . . . | R. L. 144·0 | = 13,299 |
| Therefore V = . . . . . . | | 3,777 |

$O$ = discharge of outlet or tunnel per second which may be assumed at 1,100 cusecs ;

$D$ = Required maximum discharge in escape ;

then $\frac{D}{2}$ = average discharge = $\frac{(Q - V - Ot)}{t}$ . ...... ...................... ($b$)

$$\text{and } D = \frac{2\ \{5,805\cdot5 - 3,777 - (1,100 \times 0\cdot0864)\}}{0\cdot0864}$$

$$= 44,756 \text{ cusecs.}$$

It has, however, been shown that the maximum discharging capacity of the escape with the surface of the lake at the 156·4 contour is only 40,230 cusecs. It is therefore evident that a flood such as that of November 1869 coming on a full lake could not be passed until the surface level in the lake had risen above the 156·4 contour, and probably fully up to the R. L. 157·00 contour.

*Flood that should be provided for.*

5. It may well be doubted, however, whether the flood of November 1869, as estimated, is the maximum that should be provided for. As already shown, the corresponding run-off was only slightly in excess of ⅓ of an inch per hour (for 24 hours). It is understood that the river was gauged in 1869 at a point 10 miles above the present dam, so that it did not include the whole of the catchment area. The escapages at Lake Whiting and Lake Fife were calculated for runs-off of ⅝″ and ½″, respectively, over the whole catchment for 24 hours, and considering the scantiness of the records of rainfall over the Periyar catchment area, and the want of details of the flood observations of November 1869, it seems desirable to contemplate a run-off of half an inch an hour for 24 hours.

*Discharge due to a depth of 14 feet at the tail of the escape.*

6. The Chief Engineer calculates that with a depth of 14 feet at the tail of the escape there will be a discharge of 70,330 cusecs. It will be convenient to assume that the escape bed is lowered 4 feet at head, or to R. L. 140·00, and given a bed fall of 0·7 feet so that the bed level at tail of the channel, or at the overfall, will be R. L. 139·3. The afflux at the head of the channel will then be given by formula ($a$) substituting the new values for D and $h_2$ *viz.*—

$$\frac{D}{c_1\, l\, \sqrt{2g}} = \frac{70,330}{2,610\cdot5} = 26\cdot94 = \sqrt{h_1}\ (14\cdot0 + \tfrac{2}{3}\, h_1).$$

Whence $h_1$ = 2·9 feet nearly, and the level of the surface of the lake which will give the required discharge will be R. L. 140·00 + 14·0 + 2·9 = R. L. 156·9.

*The run-off which can be provided for by a maximum discharge of 70,330 cusecs.*

7. The run-off which can be provided for by such a discharge, allowing for the flood absorptive capacity of the reservoir itself, has next to be considered. Formula ($b$) requires some modification, because if we lower the bed of the escape channel 4 feet (holding up the water by means of falling shutters), the initial discharge will not be *nil*, but will be that due to a depth of 4 feet. If $D_1$ and $D_2$ represent the initial and terminal discharges at the beginning and the end of the assumed period of 24 hours then formula ($b$) becomes—

$$\frac{(D_1 + D_2)}{2}\, t = Q - V - O\, t$$

$$\text{or } Q = \frac{(D_1 + D_2 + 2\,O)}{2}\, t + V \text{ ......................... } (c).$$

Mr. Hughes gives the discharge due to a depth of 4 feet at the lower end of the escape as 9,630 cusecs, but some allowance must be made for the loss of head due to the afflux at the head of the channel, and we may take $D_1$ = 9,270

$D_2$ = 70,330

$V$ = 3,943 M. c.f.*

| | | M. c. f. |
|---|---|---|
| * Capacity at | R. L. 156·9 | = 17,242 |
| ,, ,, | R. L. 144·0 | = 13,299 |
| Difference . . | | 3,943 |

$$\text{Then } Q = \frac{79,600 + 2,200}{2} \times 86,400 + 3,943,000,000 = 7,476,760,000 \text{ c. ft. in 24 hours,}$$

and $I$ = 86,537 cubic feet per second.

2676

This is equivalent to a run-off of 0·44 inches per hour over the whole catchment area, instead of the whole half inch proposed. If this run-off is exceeded, the surface level of the lake is likely to rise above the R. L. 156·90 contour, which shews that, even if the bed of the escape channel be lowered to the full extent now proposed, it will not give quite the full capacity which may be considered desirable, but some further relief may be given by removing the parapet of the main dam.

*Disadvantages of a permanent weir with crest at R. L. 144·00.*

8. These results are attained on the assumption that the water is held up to full supply level (R. L. 144·00) by falling shutters which are dropped in succession as the water rises above this level. The Chief Engineer however objects to the shutters and purposes to construct a permanent weir, or bar, with crest at R. L. 144·00. The effect of such a bar would be to cause a further loss of head owing to the afflux above the weir for which Mr. Hughes allows a height of 1 foot only. This second afflux will affect and somewhat reduce the afflux at the head of the escape channel. It is certain however that the total loss of head due to the combined affluxes must be much greater than that (2·9 feet) which has been shewn to be due to the afflux at head of the channel for a full discharge of 70,330 cusecs. Even if the excess is only half a foot (and it would doubtless be much more) this would involve a serious reduction in the value of $D_2$ in the preceding formula, or of the maximum or final discharging power of the escape, when the level of 156·9 had been attained in the lake. But there is a more serious objection. With falling shutters the initial discharge ($D_1$) at the R. L. 144·00 contour may be as high as 9,270 cusecs whereas with a permanent weir it will be *nil*, so that not only will the value of $D_2$ in equation (c) be greatly reduced, but that of $D_1$ will disappear altogether. It is difficult to determine quantitatively the loss of head which would be caused by the construction of a weir, at some point between the head and tail of the channel, for the short length of the escape channel, the irregularity of its bed and of the overfall in plan and many other considerations render the ordinary formulæ inapplicable, but the minimum loss will be on the assumption that the weir is placed at the head of the channel so that there will be but a single afflux. Take the lake level at R. L. 157·00, then the discharge for a depth of 14·0 feet in the escape channel will be given by the formula—

$$D = c_1 \, l \sqrt{2g} \, . \, \sqrt{h_1} \left(h - \frac{h_1}{3}\right) \quad \text{.......... (d)}$$

$$= 2{,}610{\cdot}5 \times \sqrt{3} \times 12{\cdot}0 = 54{,}246 \text{ cusecs.}$$

This corresponds very closely with the discharge calculated by Mr. Hughes for a depth of 12 feet at the tail of the escape channel. If we substitute for $D_1$ and $D_2$ in equation (c) the values *nil* and 54,246 now found, the value of I, or rate of influx per second, which can be accommodated, will be reduced from 86,537 to 73,859 cusecs, for a maximum flood level of R. L. 157·00. It has, however, been shewn that under present conditions a rate of influx of 67,193 cusecs can be accommodated for a maximum flood level of R. L. 156·4, so that there will be little advantage in incurring the expense of lowering the bed of the escape as proposed if a permanent weir with crest at R. L. 144·00 is also constructed.

*Chief Engineer's objections to falling shutters.*

9. The Chief Engineer objects to falling shutters on the ground that they could not be worked without great loss of water since they could not be raised until water had fallen 1½ or 2 feet below full lake level. There should, however, be no real difficulty in lifting the shutters against a 4 feet head of water. At Rupar shutters 6 feet in length are constantly lifted by the aid of a crane against a head of 6 feet, and recent experience at Bezwada will probably shew that the apprehensions of the Chief Engineer are unfounded. There would be no objection to a low bar such that the shutters when lying down on it would not be higher than R. L. 141·00, and the head against which they would have to be lifted would then be reduced to 3 feet. These could be raised by hand faster than the lake level will fall if a strong gang of coolies can be employed, or a travelling crane might be used as at Rupar. The simplest plan would be to construct a gantry of iron standards upstream of the line of shutters, from which the shutters could be raised into position by means of a tackle or winch, but this would be rather costly. Even allowing for establishment difficulties at Periyar, the Madras officers will no doubt be able to devise a number of ways of working falling shutters which will not involve the loss of any water, and in view of the great loss of escape power which will be caused by the erection of a non-removable dam the use of falling shutters appears to me to be obligatory.

Removal of the parapet of the main dam.

10. The proposal to cut down the parapet of the main dam to R. L. 155·00 may next be considered. It will afford very little additional escape power as this means of escape will not come into play at all until the lake has risen to R. L. 155·00. The discharge over a 600 feet* length would not be more than 6,000 cusecs with lake level at 157·00 so that the average discharge while the lake level was rising from R. L. 155·00 to 157·00 would be only 3,000 cusecs. No objection need be taken to the proposal however if it is desired to carry it out as a supplementary measure in addition to the lowering of the bed of the escape. The small quantity of water which will pass over the dam for a short time on the rare occasions of such exceptional floods as are contemplated will not injure the dam, but will provide a desirable increase in the margin of safety at a comparatively small cost.

*It would be better to pass the water over the central 500 feet only.

T. H.

Other methods of increasing the escape power.

11. There may be other ways of providing the required increase in the escape power, as for instance, by widening the escape channel, or by inserting low level undersluices in the subsidiary dam. The latter plan would be very effective as it could enable water to be passed to escape on the sudden advent of a flood even when the lake was below R. L. 144·00, but, although, as far as can be judged, the cost of both these alternatives is likely to be excessive, they may deserve consideration.

Possibility of a future increase in the storage capacity of the lake.

12. When I was at Madura with the Irrigation Commission I understood that it was contemplated that it would sooner or later be necessary to increase the storage of the lake so as to extend the area under irrigation. The escapage now proposed will however be insufficient if the full supply level is raised materially above R. L. 144·00, or if the flood absorptive capacity of the lake, as measured by the contents between the full supply and maximum flood contours, is much reduced. It must be clearly recognized that any increase in the present storage will necessitate greater escape facilities, but this strengthens rather than weakens the case for the present proposals. Any measures that may now be taken for improving the existing means of escape by lowering or widening or regrading the bed of the channel will be all to the good. If the storage is increased, it may be necessary eventually to cut down the bed to a lower level than R. L. 140·00, to increase the width, and to substitute for the inexpensive falling shutters now proposed a costly system of self-adjusting gates, like those on Lake Whiting or Lake Fife. The cost of such works will of course be fairly chargeable to the extension project, but, whatever can be now done to improve the escape or surplussing capacity of this important work, will reduce *pro tanto* the cost of future measures in the same direction which will be a *sine quâ non* if it is proposed to increase the storage.

Recommendations.

13. I recommend therefore that the Government of Madras be advised to increase the surplussing power of the escape to the extent now proposed, and suggest that this should be done by cutting down the bed of the escape channel to R. L. 140·00 at the upper, and to R. L 139·30 at the lower, end, and that the water should be held up to present full supply level (R. L. 144·00) by means of falling shutters to be hinged at the bottom and released as necessary by hand, suitable arrangements being made for lifting them against a head of 3 or 4 feet of water. If considered desirable, the parapets on the main dam may also be removed and replaced by an iron railing. If the local officers consider that the required increase in the escape power can be obtained by other more suitable or economical measures, they may be estimated for as alternative proposals, but the possibility that a further increase in the capacity of the escape may be necessary, if it is decided hereafter to increase the full supply level, should be borne in mind in submitting final proposals, although it will not be necessary to anticipate or provide for an increase of storage at present.

T. HIGHAM,
*Inspector General of Irrigation.*

*19th October 1902.*

G. I. C. P. O.—2676 96 P. W. D.—16-3-03—60.—H. R.

12 12/420 5 S/

# PERIYAR PROJECT.

## CASE 1.—HIGH FLOOD DISCHARGE OF EXISTING RIGHT BANK CHANNEL WITH SLOPE 1 IN 100.

### *A.—Tail channel discharge.*

Assume $h_2 = 5{\cdot}90$ feet.

$D = a\sqrt{r}.c\sqrt{s}$

$a = 434 \times 5{\cdot}9 = 2{,}561$

$r = \dfrac{a}{wp} = \dfrac{2{,}561}{445{\cdot}3} = 5{\cdot}74$

$\sqrt{r}$ ........................ $= 2{\cdot}40$

$c$ ........................ $= 82{\cdot}7$

$s = 0{\cdot}01$; $\sqrt{s}$ ...... $= 0{\cdot}1$

$= 2{,}561 \times 2{\cdot}4 \times 82{\cdot}7 \times 0{\cdot}1$

$= 50{,}831$ cusecs.

Mean velocity $= 19{\cdot}85$ feet per sec.

### *B.—Afflux height.*

Assume $h_1 = 5{\cdot}10$ feet.

$$\frac{D}{8{\cdot}02\, c_1\, b} = \frac{50{,}831}{8{\cdot}02 \times 0{\cdot}7 \times 434} = \frac{50{,}831}{2436} = 20{\cdot}87.$$

$$\sqrt{h_1}\left(h_2 + \frac{2}{3}h_1\right) = \sqrt{5{\cdot}1}\left(5{\cdot}9 + 3{\cdot}4\right) = 2{\cdot}26 \times 9{\cdot}3 = 21{\cdot}02.$$

The values of the two sides of the equation are thus practically the same, and the assumptions are thus practically correct, therefore :—

Afflux $= 5{\cdot}'10$ ; tail depth $= 5{\cdot}'90$ ; total flood depth $= 11{\cdot}'00$.

Discharge $= 50{,}831$ cusecs.

This discharge is equal to a run-off from the catchment of $\dfrac{50{,}831}{196{,}826} = 0{\cdot}26$ inch per hour.

G. I. C. P. O.—No. 3335 P. W. D.—12-3-1903—60—S. M. W.

# PERIYAR PROJECT.

## CASE 2.—HIGH FLOOD DISCHARGE OF LOWERED RIGHT BANK CHANNEL WITH SLOPE 1 IN 100.

### *A.—Tail channel discharge.*

Assume $h_2 = 7{\cdot}90$ feet.

$D = a\sqrt{r}\,.\,c\sqrt{s}$

$= 3{,}429 \times 2{\cdot}76 \times 87{\cdot}2 \times 0{\cdot}1$

$= 82{,}526$ cusecs.

Mean velocity $= 24{\cdot}08$ feet per sec.

$a = 434 \times 7{\cdot}9 = 3{,}429$

$r = \dfrac{a}{wp} = \dfrac{3{,}429}{449{\cdot}8} = 7{\cdot}62$

$\sqrt{r}$ ............ $= 2{\cdot}76$

$c$ ............ $= 87{\cdot}2$

$s = 0{\cdot}01$ ; $\sqrt{s}$ ...... $= 0{\cdot}1$

### *B.—Afflux height.*

Assume $h_1 = 7{\cdot}10$ feet.

$$\frac{D}{8{\cdot}02\,c_1\,b} = \frac{82{,}526}{8{\cdot}02 \times 0{\cdot}7 \times 434} = \frac{82{,}526}{2436} = 33{\cdot}87$$

$$\sqrt{h_1}\left(h_2 + \frac{2}{3}h_1\right) = \sqrt{7{\cdot}1}\,\left(7{\cdot}9 + 4{\cdot}73\right) = 2{\cdot}66 \times 12{\cdot}63 = 33{\cdot}60.$$

The values of the two sides of the equation are thus practically the same, and the assumptions are thus practically correct, therefore :—

Afflux = 7·′10 ; tail depth = 7·′90 ; total flood depth = 15·′00.

Discharge = 82,526 cusecs.

This discharge is equal to a run-off from the catchment of $\dfrac{82{,}526}{196{,}826} = 0{\cdot}42$ inch per hour.

G. I. C. P. O.—No. 3335 P. W. D.—12-3-1903.—60—S. M. W.

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PWC 3903
Recd 3. 8. 4. 03

PUBLIC WORKS DEPARTMENT,
IRRIGATION BRANCH.

# PROCEEDINGS OF THE MADRAS GOVERNMENT.

Print with note

Lowering the bed of the Periyar Escape Channel

READ the following

From the Government of India dated 16th March 1903, No.396 C.W.I.

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Note by the Chief Engineer for Irrigation. No 76 I 2.4.03

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7 D

Flag F

With endorsement No.589 I., dated 29th July 1898, estimates were forwarded for the consideration and orders of the Government of India for lowering the bed of the Periyar Escape channel and constructing a weir 150 ft on the lake side of the present weir and lowering the parapet of the main dam. The Government of India now forward a Note by Sir. T.Higham, late Inspector General of Irrigation, on the subject and direct that estimates embodying the recommendations therein made be prepared and submitted as soon as possible.

Issue

The Supg. Engineer may be directed to submit the plans and estimates for the falling shutters as ordered by the Inspector General of Irrigation. The undersigned is, however, of opinion that we should build a regulator at once with lift shutters. It is not known in this office what progress has been made in the investigation of the

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proposed increase of capacity of the Periyar lake. It may be assumed for present purposes that the project will not be sanctioned for two or three years to come. In this case it would be advisable to build a regulator at once with spans of 40ft and shutters 6 ft deep similar to those recently erected at the Upper Coleroon anient. A discharge of 100,000 cusecs may be assumed as a maximum. One of these shutters cost at the Upper Coleroon complete and fitted up Rs 5,000, the cost at Periyar may be taken at Rs 6,000. If eventually it is found necessary to raise the F.S.L. of the lake these -- shutters may become the tops of the new and deeper shutters that may then be required. The platform would in this case require raising and the chains ~~ix~~ lengthening. The gearing ~~to~~ of winches ~~arches~~ should be made now sufficiently strong to work the heavier shutter.

Order thereon. No. 420 I. of 9.4.1903

Irrign Asst

The Supr. Engineer, 6th Circle, will submit the plans and estimates for the falling shutters as recommended by the Inspector-General of Irrigation.

4-4-03

2. Ordered that a copy of these Proceedings be forwarded to the Government of India for information with reference to their letter No.396 C.W.I., dated

16th

I. Form No. 1—1,000—10-8-01.

15 15/420

16th March 1903.

Endorsement. No. 421 I. d/9.4.1903

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Forwarded.

Despd 2/6/03.

DS 1/4/03

2/4/03

To

The Chief Engr. for Irrign. 2/6/03.

,, Supg. Engr. VI Circle, with plans & estimates and a blue print of Upper Coleroon shutters.

DESPATCHED
- 4 JUN 1903

1.4.03

16 16/420

U. E. D.

Will you kindly return the original G.O. No. 420-I.D. & the spare copies as soon as possible. They were sent to your office sometime ago for pasting diagrams.

[signature] 20/5/03

Head Clerk

S.E.D.

[initials]
20/5/03

C.E.D.
20.5.03

S.E.D.

Blue prints (146 copies) were taken & handed over to Mech. Draftsman some 10 days back to cut & paste the sketches in their respective places in printed G.O. A sample

H.C.
———
W.

Herewith 50 copies of the G.O. with diagrams etc. printed [illegible] for immediate requirements. The [illegible] copies of the order are being pasted over & will be sent as soon as ready.

A.S.N.
25.5.03.

Telephone message

From 17 17/420

Manager

P.W.D. (Engin^r)

To

The Supt. Govt. Press.

Copies of G.O. No. 420 & 421. I of 9^th April 1903 may be sent here where the blue prints will be pasted.

[illegible]

R.C. Keep till asked for [illegible]

C.S.I.

[illegible] 30/4/03

Please note that 142 copies each of the blue prints in the Inspr. Genl's note [illegible] will be required.

C.I. 6/5/03

[illegible] 30/4

[illegible] 20/4

[illegible]

Telephone

From Supdt
Govt Press

~~Telephone~~ Press

Copies of S20
421 I ~~am~~ have bee
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Press. ...

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you for the

Recd 3 pm

Please send a copy
of the G.O. copy with
the original

[illegible] 24/4/03

Telephone

From Supdt of Govt Press  18/420

To H.C. [illegible] Pard

A copy of GO 420 -1 2d/9-4-03 was sent with original on 29th April as asked for in Telephone of this date

[illegible]

~~Frd D.~~

~~The original of G.O.~~

F. E. D.

The original of G.O. No 420-1 9d/9-4-03 was sent to you on the 30th April 1903.

[illegible]
6-5-03.

17

19/420 P. W. D.

To. Telephone

~~NOTE, FOR~~ THE SUPERINTENDENT,
GOVERNMENT PRESS.

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Please return the original G.O. No 420-19 dated 9-4-03.

[signature] 5/5

H.C.

8/[illegible] 5/5

20

20/420

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Please let me have the original copy with blue print pasted on it for a while [illegible]

H.D.
B.S.

[illegible]
5/5/03

Please let me have the original of the [illegible]

[illegible]
5/5/03

Memo.

21/5/03 [illegible]

The Despatcher,

P. W. Secretariat, Chepauk.

Cd. — Are the blue copies ready please? [illegible] 5/5/03

Sir,

Copies of G. O. No. 420, 421 I., are sent for the pasting of blue prints in your office, as per telephone. Please send to press 12 Complete Copies (with blue prints pasted) for the monthly Volume.

F. S. D. — will you kindly arrange for this or send the blue prints to me. [illegible] 5/5/03

Ruthnam [illegible]

Foreman P.W.D.

[illegible] 03.